A New Impact Assessment Method to Evaluate Knowledge Resources

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ABSTRACT

Rationale: Methods to systematically measure the impact of knowledge resources on health professionals would enhance evaluation of these resources in the real world. Objective: To propose a new impact assessment method. Background: We demonstrated the feasibility of combining a 4-level scale with Computerized Ecological Momentary Assessment (CEMA) for efficiently measuring the impact of a knowledge resource. Method: We critically reviewed the world literature regarding the impact of clinical information-retrieval technology on trainees and doctors, and retained 26 papers for qualitative content analysis. Findings: Of those, 21 use a nominal scale (yes/no), none systematically measures the impact of searches for information outside of a laboratory setting, and none uses an ordinal scale. The literature supports the proposed levels of impact, and suggests a fifth level. Conclusion: A new impact assessment method is proposed, which combines a 5-level revised scale and CEMA.

INTRODUCTION

The development of methods to evaluate the impact of knowledge resources for health professionals is a challenge. Although technology improves access to information, knowledge resources do not integrate self-assessment tools to systematically assess their impact. The present paper reviews the literature, and proposes a new impact assessment method to evaluate knowledge resources.

BACKGROUND

Knowledge resources promise benefits for health professionals, notably on handheld computers [1]. Handheld knowledge resources can provide health professionals with Clinical Information-Retrieval Technology (CIRT) and Clinical Decision Support Systems (CDSS) at the point-of-care or at the moment-of-need to support evidence-based practice. However, "the evidence in support of the technology itself is only beginning to trickle in" [1].

We have termed databases that are mostly text CIRT (e.g. electronic textbooks or Medline). According to a theoretical model, health professionals may retrieve information by searching CIRT (acquisition), integrate it (cognition), and use it (application) to decisions about multiple patients, unlike patient data [2]. This information consists of explicit clinical knowledge about health education or promotion, prevention, diagnosis, therapy and prognosis, and may include images, sound and movies, as well as multimedia [3]. CIRT is distinct from CDSS such as clinical prediction rules and calculators, which require the user to enter patient-specific data to obtain risk estimates, probability of diagnosis and treatment recommendations. CDSS match reference information with patient-related data to provide patient-specific recommendations.

While CDSS may improve practitioner performance [4] the impact of CIRT is still under debate [5]. Thus, the first two authors explored impacts of CIRT on doctors using a case study method embedded in the evaluation of a commercial handheld knowledge resource *(InfoRetriever)* [6]. Findings suggested six types of cognitive impact at four levels: (++) highly positive (practice improvement, learning and recall), (+) moderately positive (reassurance and confirmation), (0) no impact, and (-) negative impact (frustration).

Subsequently, an original method to evaluate knowledge resources was tested in a cohort of 26 Family Medicine residents, by systematically assessing the impact of their searches for information in everyday practice [7]. Using the technique of Computerized Ecological Momentary Assessment (CEMA) [8], the first three authors integrated *InfoRetriever* 2003 (to provide access to both CIRT and CDSS), with an electronic questionnaire which allowed residents to report the perceived impact of each item of information (each hit) retrieved on handheld computer (e.g. a summary of a published research report). The impact of CIRT-related hits was

compared with that of CDSS-related hits. CIRT information hits were defined as any hit in the following *InfoRetriever* databases: Abstracts of Cochrane Reviews, InfoPOEMs, evidence-based practice guideline summaries and the Griffith's 5-Minute Clinical Consult. CDSS information hits were defined as any hit in: Clinical Prediction Rules, History and Physical Exam diagnostic calculator and Diagnostic Test calculator. The impact assessment questionnaire was linked to 5,160 hits. Of those, 4,946 impact assessment questionnaires were answered (95.9%), and 2,495 contained reports of impact (48.4%). Reports of positive impact on residents were most frequently in the areas of learning and practice improvement. In comparison to CDSS, CIRT hits were more frequently associated with learning and recall. CDSS hits were more frequently associated with reports of practice improvement.

This cohort study demonstrates the feasibility of systematic and comparative assessment of self-reported cognitive impact associated with the use of a knowledge resource by health professionals in everyday life, regardless of resource (CIRT or CDSS). The present paper specifically aims to examine the literature according to the types of impact in our proposed scale, to explore new types, and so to propose the most comprehensive impact assessment method available for evaluative research in professional education and technology development.

METHOD

We reviewed the literature on the impact of CIRT on trainees and doctors in practice. Given the paucity of experiments in this field, all research designs were sought (quantitative, qualitative and mixed methods studies). Impact was defined as any change, consequence, effect, influence, modification or outcome associated with the use of CIRT. Our literature review is presented in detail elsewhere [9].

The world literature was reviewed up to February 2004. Using inclusion/exclusion criteria, two reviewers independently identified studies by scrutinizing 3,368 and 3,249 references from multiple bibliographic databases. Additional studies were retrieved by hand searches in journals, proceedings, textbooks, literature reviews, personal files, selected publications, and by searching ISI Web of Science for citations of relevant articles.

With respect to the impact of CIRT on physicians, 605 articles on paper were assessed for relevance. Of those, 565 were excluded as there was no mention of quantitative results or qualitative findings of impact, while 40 (6.6%) were independently appraised by two reviewers for relevance and methodological quality by type of study (quantitative, qualitative or mixed methods). Disagreements between reviewers were resolved by consensus, and 26 (4.3%) articles were retained for further analysis. According to these studies, information found within CIRT may affect, alter, change, confirm, improve, influence or help physician practice, clinical decision-making, patient care (current or future patient), compliance with guidelines, ability to answer questions and doctor-patient relationship.

For each retained article, a content analysis was performed on extracted textual material, namely impact-related text in regard to assessment methods, qualitative findings and quantitative results. The latter textual data were assigned to mentioned types and levels of impact, and authors reached consensus on these assignments. Non-assigned textual extracts overlapped two types, and referred to non-specific impacts (e.g. "influence") or indirect impacts on the doctor-patient relationship, inter-professional relationships, patient health and health system issues (e.g. reduction of healthcare costs). Findings are presented below with respect to assessment methods and assignments to six types of impact at four levels.

FINDINGS

Of 26 studies, 21 (81%) use nominal scales to evaluate impact [5,10-29]. The typical question is "Does CIRT have an impact?" leading to yes/no answers (Table 1). No studies use an ordinal scale to assess the impact of CIRT on trainees and doctors. In addition, there are no reports of a longitudinal field study to systematically measure the impact of searches for information outside of a lab setting.

Five studies (19%) use interval measures to globally assess the impact of CIRT on doctors [30-34]. Of those, three are laboratory studies where measurement consists of knowledge tests based on clinical scenarios (e.g. 20 questions over a 30-minute test) [30,32,33]. Outside the lab, one randomized controlled trial uses a locally validated standardized questionnaire to measure attitudes and intentions associated with access to *InfoRetriever* over a two-month period [31]. Finally, a prospective case-comparison study measured healthcare costs and lengths of stay associated with the use of CIRT [34].

The textual data analysis shows that 11 studies refer to one proposed type of impact, and that seven studies echo more than one type. <u>High positive impact</u>: Five studies report *practice improvement* [5,10,15,25,29]. One randomized controlled trial demonstrates that access to *InfoRetriever* improves medical students' *learning* [31], and six studies report learning experiences [5,12, 15,22,25,29]. Two studies suggest that use of CIRT is associated with *recall* [5,33].

<u>Moderate positive impact:</u> The above-mentioned trial demonstrates that access to

InfoRetriever provides *reassurance* to medical students, expressed as a gain in self-perceived confidence [31]. Two other studies observe *reassurance* [5,19]. Five studies indicate that CIRT may *confirm* decision-making [5,11,23,25,29].

No impact: One randomized controlled trial demonstrates that use of computerized guidelines is not associated with guideline adherence in primary care [14]. Three laboratory studies show that the use of CIRT is not associated with the ability to solve clinical scenarios [21,30,32]. Five observational studies indicate that use of CIRT has *no impact* when there is not enough information or too much information [17,19,23,25,29].

Negative impact: Three studies suggest CIRT may generate *frustration* or complete dissatisfaction [5,28,29]. Furthermore, Lindberg et al. [25] state that "no cases were reported in this study in which use of the information retrieved via Medline caused harm to the patient, although it is acknowledged that this could happen."

Table 1 Literature review: CIRT impact assessment and levels of impact

Studies sorted by year	Assessment[1]		*Design*[2]			Levels of impact[3]			
First author (year)	Nominal scale	Interval scale	*Experim.*	*Observat.*	*Lab*	High positive	Moderate positive	Nil	Negative
Pluye (2004) [5]	**SR**			*X*		++	+		-
Sintchenko (2004) [30]		**IA**			*X*			**0**	
Westbrook (2004) [10]	**SR**			*X*		++			
Crowley (2003) [11]	**SR**			*X*			+		
Leung (2003) [31]		**SR**	*X*			++	+		
Schwartz (2003) [12]	**SR**			*X*		++			
Cullen (2002) [13]	**SR**			*X*					
Jousimaa (2002) [14]	**IA**		*X*					**0**	
Rothschild (2002) [15]	**SR**			*X*		++			
Baker (2001) [16]	**IA**			*X*					
Brassey (2001) [17]	**SR**			*X*				**0**	
Del Mar (2001) [18]	**SR**			*X*					
Lapinsky (2001) [32]		**IA**			*X*			**0**	
Swinglehurst (2001) [19]	**SR**			*X*			+	**0**	
Eberhart-Phillips (2000) [20]	**SR**			*X*					
Wildemuth (2000) [33]		**IA**			*X*	++			
Abraham (1999) [21]	**IA**				*X*			**0**	
Hayward (1999) [22]	**SR**			*X*		++			
Jousimaa (1998) [23]	**SR**			*X*			+	**0**	
Gorman (1994) [24]	**SR**			*X*					
Klein (1994) [34]		**IA**		*X*					
Lindberg (1993) [25]	**SR**			*X*		++	+	**0**	
Veenstra (1992) [26]	**SR**			*X*					
Haynes (1991) [27]	**SR**		*X*						
Angier (1990) [28]	**SR**			*X*					-
Haynes (1990) [29]	**SR**			*X*		++	+	**0**	-

1. Assessment: Impact self-reported by participants (SR) or independently assessed (IA)
2. Design: Experimental (Experim.), observational (Observat.) or laboratory (Lab) study
3. Levels: High positive (practice improvement, learning, recall), moderate positive (reassurance, confirmation), no impact, negative (frustration)

DISCUSSION

Findings indicate that outside our work [7], no ordinal scales exist to systematically measure the impact of searches within CIRT. In addition, our findings support the proposed types of impact in our 4-level scale, and suggest one refinement and one modification. In terms of refinement, we expand on negative impact, as frustration may occur when health professionals find no information or too much information. Indeed, information overload might increase anxiety rather than reduce uncertainty [35].

Second, we modify our impact assessment scale to recognize wrong or potentially harmful information. This suggests the existence of a new fifth level, namely (--) strong negative impact. For example, using information from the Internet is obviously risky "as anyone can publish any information they like" [36]. Moreover, even medical guidelines may contain misleading information [37], which computerization cannot prevent. In clinical practice, a case report describes how doctors may use information in a potentially harmful manner [38].

The present paper faces two limitations. We do not examine the process of searching for information (e.g. information retrieval skills). We focus on cognitive impacts of information on health professionals, and do not examine other types of impact (e.g. patient health).

Our findings and a content validity exercise with 20 professionals lead us to propose a new 5-level 10-item ordinal impact assessment scale to evaluate the impact of information hits on health professionals regardless the electronic resource. This scale corresponds to categorical judgments (yes/no responses to 10 items) using ordered categories (5 levels), and investigates behaviors (associated with information hits) and attitudes (feelings about information hits). Strongly positive impact: The impact of information hits can be linked to a positive change in decision-making for the current patient (or to a commitment to change). The construct *change* refers to two items (practice improvement, learning). Moderately positive impact: The impact of information hits can be linked to the reinforcement of decision-making. There is no change in decision-making, but a positive effect or influence on the professional (e.g. by encouraging their usage of electronic resources). The construct *reinforcement* refers to two items (reassurance, confirmation). Neutral: Information hits may have no impact (one item). Moderately negative impact: The impact of information hits can be linked to a feeling of dissatisfaction because a need is not satisfied. There is no change in decision-making, but a negative effect or influence on the professional (e.g. by discouraging their usage of electronic resources). The construct *dissatisfaction* refers to two items (nothing useful, too much information). Strongly negative impact: The impact of information hits can be linked to suspicion and loss of confidence in an electronic resource. There might be a negative effect on decision-making for a patient if this information is used (e.g. by exposing patients' to potentially ineffective and even harmful treatments). The construct *dissatisfaction* refers to two items (disagreement, potential harm). A 10^{th} scale item (recall) may be linked to more than one construct (e.g. change or reinforcement).

When combined with CEMA [8], this 5-level scale constitutes a new impact assessment method to evaluate or compare resources. Our method permits to collect real-time self-reported behaviors (e.g. practice improvement) or attitudes (e.g. learning). Some information hits might be used in the future (attitude). As mentioned in the Background section, our cohort study demonstrates that it is feasible/acceptable to systematically assess the cognitive impact of information hits on health professionals, by integrating an electronic scale-based questionnaire within knowledge resources using CEMA [7]. This questionnaire may pop up for opened information hits, and so health professionals might efficiently report the perceived impact of each hit.

CONCLUSION

This new method constitutes a proposal, and further measurement study is needed. Once validated, the method may be used to systematically measure the cognitive impact of information hits derived from electronic knowledge resources, and to enhance real-time professionals' evaluation of these resources.

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